REMARKS

The Office Action mailed April 3, 2007 has been carefully reviewed and the foregoing amendment has been made in consequence thereof

Claims 1-8 are now pending in this application. Claims 1-8 stand rejected.

The objection to the specification is respectfully traversed. Applicants have amended page 2, lines 5-9, page 7, lines 14-17, and the Title to address the issues raised in the Office Action. For the reasons set forth above, Applicants request that the objection to the specification be withdrawn.

The rejection of Claims 1, 3-5, 7, and 8 under 35 U.S.C. §103(a) as being unpatentable over Wyman et al. (U.S. Pat. No. 7,106,891) ("Wyman") in view of Ayala et al. ("Spatial Size Distributions: Applications to Shape and Texture Analysis," IEEE, December 2001, pp. 1430-1442) ("Ayala") is respectfully traversed.

Wyman describes a method and system for determining convergence when registering image sets. A computed tomography (CT) image set (110) and a magnetic resonance image (MRI) image set (105) are received (410) by an Enhanced Image Registration System (ERIS) (120). The EIRS (120) compares (420) the two image sets, for example, by using Mutual Information, and performs (425) multiple transformation iterations on the CT image set (110) to align it with the MRI image set (105). The ERIS (120) then determines (430 and 440) when the image sets (110 and 105) are sufficiently aligned using convergence techniques. The image sets (110 and 105) are considered to be aligned when the magnitude of the transformation has converged as determined by comparing a convergence value to a predetermined threshold (t). More specifically, the ERIS (120) determines (430) the magnitude of the transformations performed by examining specific points within the CT image set (110) after each transformation. When the change in magnitude between succeeding transformations is below the predetermined threshold (t), the ERIS (120) determines (440) that the magnitude of transformation has converged. The aligned image sets (110 and 105) are output (450) from the ERIS (120) to generate a transformed CT image set (125) that is aligned with the MRI image set (105).

Applicants respectfully traverse the assertion on page 3 of the Office Action that Wyman describes "calculating mutual information shared by each of the transformed candidate images and the reference image," at column 10, lines 5-47, namely, steps 430 and 440. Applicants respectfully submit that Wyman at column 10, lines 5-47 does not include any reference to mutual information. Rather, Wyman describes that "[t]he Image Comparison module 420 of one embodiment of the EIRS measures the Mutual Information for comparing images to determine whether or not they are aligned. Another embodiment further refines the computation of Mutual Information by using stochastic approximation techniques for sampling the image." Column 12, lines 5-10. As such, Wyman describes using mutual information to initially determine whether or not image sets (110 and 105) are aligned, and does not describe nor suggest calculating mutual information shared by each of the transformed candidate images and the reference image. In fact, Wyman teaches away from using mutual information for determining convergence as supported by the recitation that "[b]ecause of the stochastic implementation used to calculate MI the measure is very noisy, making it impossible without the use of a large windowed low-pass filter to determine the point of convergence." Column 14, lines 51-56.

Furthermore, Applicants respectfully traverse the assertion on page 3 of the Office Action that Wyman describes "selecting a candidate image, which shares the largest amount of mutual information with the reference image, from among the plurality of candidate images," at column 10, lines 8-13, and that "the image that matches the most data is selected at step 450". Applicants respectfully submit that Wyman at column 10, lines 8-13 does not include any reference to mutual information or to selecting an image which shares the largest amount of mutual information with a reference image. Rather, Wyman describes that at step 450 "the registration process is complete and the aligned second image set is outputted from the ERIS." Column 10, lines 12-13. As such, Wyman describes outputting a set of images that are aligned with a reference image set, and does not describe nor suggest selecting a candidate image, which shares the largest amount of mutual information with the reference image, from among the plurality of candidate images. In fact, Wyman teaches away from selecting a candidate image, which shares the largest amount of mutual information with the reference image, from among the plurality of candidate images, by describing that a set of images is output at step 450. Outputting a set of registered and aligned images is not analogous to or suggest of selecting a candidate image from among the plurality of candidate images.

Accordingly, Wyman does not describe nor suggest calculating mutual information shared by each of the transformed candidate images and a reference image. Further, Wyman does not describe nor suggest selecting a candidate image, which shares the largest amount of mutual information with a reference image, from among a plurality of candidate images. Additionally, Wyman does not describe nor suggest extracting a plurality of candidate images similar to a reference image from among a plurality of images by utilizing granulometry.

Ayala describes a method of analyzing shapes and textures within images. Granulometric analysis is combined with the comparison of an original image and its granulometric transformation to classify texture. Ayala describes that granulometry and granulometric size distributions are used to define probability distributions for binary and gray-scale images. Notably, Ayala does not describe nor suggest extracting a plurality of candidate images similar to a reference image from among a plurality of images by utilizing granulometry. Further, Ayala does not describe nor suggest calculating mutual information shared by each of the transformed candidate images and a reference image. Moreover, Ayala does not describe nor suggest selecting a candidate image, which shares the largest amount of mutual information with a reference image, from among a plurality of candidate images.

Claim 1 recites an image processing method comprising the steps of "extracting a plurality of candidate images similar to a reference image from among a plurality of images by utilizing granulometry; transforming the plurality of candidate images on the basis of the reference image; calculating mutual information shared by each of the transformed candidate images and the reference image; and selecting a candidate image, which shares the largest amount of mutual information with the reference image, from among the plurality of candidate images."

Neither Wyman nor Ayala, considered alone or in combination, describes or suggests an image processing method as recited in Claim 1. More specifically, neither Wyman nor Ayala, considered alone or in combination, describes or suggests a method that includes calculating mutual information shared by each of the transformed candidate images and a reference image. Rather, in contrast to the present invention, Wyman describes using mutual information to determine whether or not evaluation and reference image sets are aligned, and Ayala describes that granulometry and granulometric size distributions may be used to define probability distributions for binary and gray-scale images.

Furthermore, neither Wyman nor Ayala, considered alone or in combination, describes or suggests a method that includes selecting a candidate image, which shares the largest amount of mutual information with a reference image, from among a plurality of candidate images. Rather, in contrast to the present invention, Wyman describes outputting an image set that is registered and aligned with a reference image set, and Ayala describes that granulometry and granulometric size distributions may be used to define probability distributions for binary and gray-scale images.

Moreover, neither Wyman nor Ayala, considered alone or in combination, describes or suggests a method that includes extracting a plurality of candidate images similar to a reference image from among a plurality of images by utilizing granulometry. Rather, in contrast to the present invention, Wyman describes an ERIS that receives an evaluation image set and a reference image set, and Ayala describes that granulometry and granulometric size distributions may be used to define probability distributions for binary and gray-scale images.

Accordingly, for at least the reasons set forth above, Claim 1 is submitted to be patentable over Wyman in view of Ayala.

Claims 3 and 4 depend from independent Claim 1. When the recitations of Claims 3 and 4 are considered in combination with the recitations of Claim 1, Applicants submit that Claims 3 and 4 likewise are patentable over Wyman in view of Ayala.

Claim 5 recites an image processing apparatus comprising "an extracting means for extracting a plurality of candidate images similar to a reference image from among a plurality of images by utilizing granulometry; a transforming device for transforming the plurality of candidate images on the basis of the reference image; a calculating device for calculating mutual information shared by each of the transformed candidate images and the reference image; and a selecting device for selecting a candidate image, which shares the largest amount of mutual information with the reference image, from among the plurality of candidate images."

Neither Wyman nor Ayala, considered alone or in combination, describes or suggests an image processing apparatus as recited in Claim 5. More specifically, neither Wyman nor Ayala, considered alone or in combination, describes or suggests an image processing apparatus that includes a calculating device for calculating mutual information shared by each

of the transformed candidate images and a reference image. Rather, in contrast to the present invention, Wyman describes using mutual information to determine whether or not evaluation and reference image sets are aligned, and Ayala describes that granulometry and granulometric size distributions may be used to define probability distributions for binary and gray-scale images.

Furthermore, neither Wyman nor Ayala, considered alone or in combination, describes or suggests an image processing apparatus that includes a selecting device for selecting a candidate image, which shares the largest amount of mutual information with a reference image, from among a plurality of candidate images. Rather, in contrast to the present invention, Wyman describes outputting an image set that is registered and aligned with a reference image set, and Ayala describes that granulometry and granulometric size distributions may be used to define probability distributions for binary and gray-scale images.

Moreover, neither Wyman nor Ayala, considered alone or in combination, describes or suggests an image processing apparatus that includes an extracting means for extracting a plurality of candidate images similar to a reference image from among a plurality of images by utilizing granulometry. Rather, in contrast to the present invention, an ERIS that receives an evaluation image set and a reference image set, and Ayala describes that granulometry and granulometric size distributions may be used to define probability distributions for binary and gray-scale images.

Accordingly, for at least the reasons set forth above, Claim 5 is submitted to be patentable over Wyman in view of Ayala.

Claims 7 and 8 depend from independent Claim 5. When the recitations of Claims 7 and 8 are considered in combination with the recitations of Claim 5, Applicants submit that Claims 7 and 8 likewise are patentable over Wyman in view of Ayala.

Additionally, in contrast to the assertions in the Office Action, Applicants respectfully submit that it would not have been obvious to one skilled in the art to combine the teachings of Wyamn with the teachings of Ayala to arrive at the present invention. More specifically, Applicants submit that Wyman teaches away from the present invention. If art "teaches away" from a claimed invention, such a teaching supports the nonobviousness of the invention. U.S. v. Adams, 148 USPQ 479 (1966); Gillette Co. v. S.C. Johnson & Son, Inc., 16 USPQ2d 1923, 1927 (Fed. Cir. 1990). In light of this standard, it is respectfully submitted

that the cited art, as a whole, is not suggestive of the presently claimed invention. More specifically, Wyman is directed to using mutual information to initially determine whether or not image sets are aligned. Wyman describes that calculations yielding mutual information are noisy, such that mutual information is not suitable for determining convergence of magnitudes of transformation. As such, one of ordinary skill in the art would not look to Wyman, which describes that mutual information is noisy, but may be used to determine alignment, to arrive at the presently pending claims.

For at least the reasons set forth above, Applicants respectfully request that the Section 103 rejection of Claims 1, 3-5, 7, and 8 be withdrawn.

The rejection of Claims 2 and 6 under 35 U.S.C. §103(a) as being unpatentable over Wyman in view of Ayala, and further in view of Nakajima et al. (U.S. Pat. No. 5,623,560) ("Nakajima") is respectfully traversed.

Wyman and Ayala are described above. Nakajima describes a method for adjusting positions of radiation images. First and second phosphor sheets (5 and 7) are stacked with a filter (6) intervening therebetween. An object (4) is irradiated to generate first and second X-ray images on respective phosphor sheets (5 and 7). The phosphor sheets (5 and 7) are placed one after the other at a predetermined position in an X-ray image read-out apparatus (10). An amount of emitted light (22) represented on the first phosphor sheet (5) is converted to an electric signal (SO1), and an electrical signal (SO2) is similarly generated from the second phosphor sheet (7). The electric signals (SO1 and SO2) are used to transform coordinates in the first X-ray image with affine transformation. The affine transformation simultaneously carries out enlargement or reduction, rotation, and/or parallel translation of the first X-ray image. As such, the first X-ray image is superimposed on the second X-ray image.

Notably, Nakajima does not describe nor suggest calculating mutual information shared by each of the transformed candidate images and a reference image. Further, Nakajima does not describe nor suggest selecting a candidate image, which shares the largest amount of mutual information with a reference image, from among a plurality of candidate images. Moreover, Nakajima does not describe nor suggest extracting a plurality of candidate images similar to a reference image from among a plurality of images by utilizing granulometry.

Claim 1 recites an image processing method comprising the steps of "extracting a plurality of candidate images similar to a reference image from among a plurality of images by utilizing granulometry; transforming the plurality of candidate images on the basis of the reference image; calculating mutual information shared by each of the transformed candidate images and the reference image; and selecting a candidate image, which shares the largest amount of mutual information with the reference image, from among the plurality of candidate images."

None of Wyman, Ayala, and Nakajima, considered alone or in combination, describe or suggest an image processing method as recited in Claim 1. More specifically, none of Wyman, Ayala, and Nakajima, considered alone or in combination, describe or suggest a method that includes calculating mutual information shared by each of the transformed candidate images and a reference image. Rather, in contrast to the present invention, Wyman describes using mutual information to determine whether or not evaluation and reference image sets are aligned, Ayala describes that granulometry and granulometric size distributions may be used to define probability distributions for binary and gray-scale images, and Nakajima describes an affine transformation that simultaneously carries out enlargement or reduction, rotation, and/or parallel translation of an X-ray image.

Furthermore, none of Wyman, Ayala, and Nakajima, considered alone or in combination, describe or suggest a method that includes selecting a candidate image, which shares the largest amount of mutual information with a reference image, from among a plurality of candidate images. Rather, in contrast to the present invention, Wyman describes outputting an image set that is registered and aligned with a reference image set, Ayala describes that granulometry and granulometric size distributions may be used to define probability distributions for binary and gray-scale images, and Nakajima describes an affine transformation that simultaneously carries out enlargement or reduction, rotation, and/or parallel translation of an X-ray image.

Moreover, none of Wyman, Ayala, and Nakajima, considered alone or in combination, describe or suggest a method that includes extracting a plurality of candidate images similar to a reference image from among a plurality of images by utilizing granulometry. Rather, in contrast to the present invention, Wyman describes an ERIS that receives an evaluation image set and a reference image set, Ayala describes that granulometry and granulometric size distributions may be used to define probability distributions for binary

and gray-scale images, and Nakajima describes an affine transformation that simultaneously carries out enlargement or reduction, rotation, and/or parallel translation of an X-ray image.

Accordingly, for at least the reasons set forth above, Claim 1 is submitted to be patentable over Wyman in view of Ayala, and further in view of Nakajima.

Claim 2 depends from independent Claim 1. When the recitations of Claim 2 are considered in combination with the recitations of Claim 1, Applicants submit that Claim 2 likewise is patentable over Wyman in view of Ayala, and further in view of Nakajima.

Claim 5 recites an image processing apparatus comprising "an extracting means for extracting a plurality of candidate images similar to a reference image from among a plurality of images by utilizing granulometry; a transforming device for transforming the plurality of candidate images on the basis of the reference image; a calculating device for calculating mutual information shared by each of the transformed candidate images and the reference image; and a selecting device for selecting a candidate image, which shares the largest amount of mutual information with the reference image, from among the plurality of candidate images."

None of Wyman, Ayala, and Nakajima, considered alone or in combination, describe or suggest an image processing apparatus as recited in Claim 5. More specifically, none of Wyman, Ayala, and Nakajima, considered alone or in combination, describe or suggest an image processing apparatus that includes a calculating device for calculating mutual information shared by each of the transformed candidate images and a reference image. Rather, in contrast to the present invention, Wyman describes using mutual information to determine whether or not evaluation and reference image sets are aligned, Ayala describes that granulometry and granulometric size distributions may be used to define probability distributions for binary and gray-scale images, and Nakajima describes an affine transformation that simultaneously carries out enlargement or reduction, rotation, and/or parallel translation of an X-ray image.

Furthermore, none of Wyman, Ayala, and Nakajima, considered alone or in combination, describe or suggest an image processing apparatus that includes a selecting device for selecting a candidate image, which shares the largest amount of mutual information with a reference image, from among a plurality of candidate images. Rather, in contrast to the present invention, Wyman describes outputting an image set that is registered

and aligned with a reference image set, Ayala describes that granulometry and granulometric size distributions may be used to define probability distributions for binary and gray-scale images, and Nakajima describes an affine transformation that simultaneously carries out enlargement or reduction, rotation, and/or parallel translation of an X-ray image.

Moreover, none of Wyman, Ayala, and Nakajima, considered alone or in combination, describe or suggest an image processing apparatus that includes an extracting means for extracting a plurality of candidate images similar to a reference image from among a plurality of images by utilizing granulometry. Rather, in contrast to the present invention, an ERIS that receives an evaluation image set and a reference image set, and Ayala describes that granulometry and granulometric size distributions may be used to define probability distributions for binary and gray-scale images, and Nakajima describes an affine transformation that simultaneously carries out enlargement or reduction, rotation, and/or parallel translation of an X-ray image.

Accordingly, for at least the reasons set forth above, Claim 5 is submitted to be patentable over Wyman in view of Ayala, and further in view of Nakajima.

Claim 6 depends from independent Claim 5. When the recitations of Claim 6 are considered in combination with the recitations of Claim 5, Applicants submit that Claim 6 likewise is patentable over Wyman in view of Ayala, and further in view of Nakajima.

For at least the reasons set forth above, Applicants respectfully request that the Section 103 rejection of Claims 2 and 6 be withdrawn.

In view of the foregoing amendment and remarks, all the claims are now active in this application are believed to be in condition for allowance. Reconsideration and favorable action is respectfully solicited.

Respectfully submitted,

Patrick W. Rasche
Reg. No. 37,916
ARMSTRONG TEASDALE LLP
One Metropolitan Square, Suite 2600
St. Louis, Missouri 63102-2740
(314) 621-5070